ARTICLE – The relationship between resource utilisation and inflation

Sweden and other countries have had low inflation for a number of years. One important explanation for this is that the recession period has been prolonged. At the same time, the fact that demand and thus resource utilisation in Sweden have risen in recent years has been a factor behind the upturn in inflation since early 2014. A statistical analysis shows that a high level of resource utilisation in the economy tends to be followed by higher inflation, albeit with some time lag. The Riksbank's very expansionary monetary policy provides support to the upturn in resource utilisation and inflation. Although it is uncertain how quickly the rising resource utilisation will have an impact on inflation and how large the effect will ultimately be, historical correlations indicate that inflation will continue to rise.

In what way does resource utilisation affect inflation?

Both companies' costs and mark-ups - and thereby inflation - vary according to demand in the economy. In a strong economic situation with high employment and low unemployment, the economy's resources are used to a greater degree. Then companies' costs normally rise and they also find it easier to pass on their cost increases to consumer prices. In the reverse situation, with low resource utilisation in the economy, inflation instead tends to be low.

The development of inflation is also influenced by the exchange rate. The stronger the krona is, the less Swedish companies and consumers need to pay in Swedish krona for imported goods. Companies' price-setting is also influenced by inflation expectations in the corporate and household sectors.

The relationship between inflation and resource utilisation is often described in terms of a variation of the so-called Phillips curve.[9] Put simply, this states that inflation tends to be high when economic activity is strong and low when economic activity is weak. There is extensive literature in this field and a long line of studies of the relationship have been made over the years, but with varying results. In later studies, however, the conclusion has generally been that a higher resource utilisation covaries with higher inflation.[10] The studies also show that the relationship has been relatively stable over time in developed countries.

Although the Phillips curve offers a conceptual framework, its practical use is not uncomplicated, but rather governed by a number of considerations. For example, resource utilisation cannot be observed directly and there is no general agreement with regard to the best way of measuring it. The fact that there is a link between two variables does not necessarily mean that there is a causal relationship between the variables. Inflation can fluctuate as a result of other factors than those captured by changes in resource utilisation and these factors can influence both inflation and resource utilisation.

How have inflation and resource utilisation covaried in Sweden?

One simple method of illustrating the relationship empirically is to look at correlations between resource utilisation and inflation.[11] Resource utilisation can be summarised in a number of different measures, for instance, GDP and various types of labour market gaps. Regardless of which measures are chosen, there appears to be some positive co-variation with inflation. Correlations also show that the effect on inflation is delayed. A high level of resource utilisation in the economy thus tends to be followed by higher inflation after some time lag.

Figure 4:20 shows how different measures of resource utilisation in Sweden covary with inflation.[12] The starting point on the left of each line in the figure shows the

[9] The Phillips curve has taken its name from economist William Phillips, who observed in 1958 a negative relationship between unemployment and the rate of change in nominal wages in the United Kingdom. Today, the so-called New-Keynesian Phillips Curve is the most commonly used model of the relationship, see Mavrocidis, Plagborg-Möller and Stock (2014), "Empirical Evidence on Inflation Expectations in the New Keynesian Phillips Curve", Journal of Economic Literature 52(1), pp.124-188. In this article, however, we focus on simpler variations of the relationship.
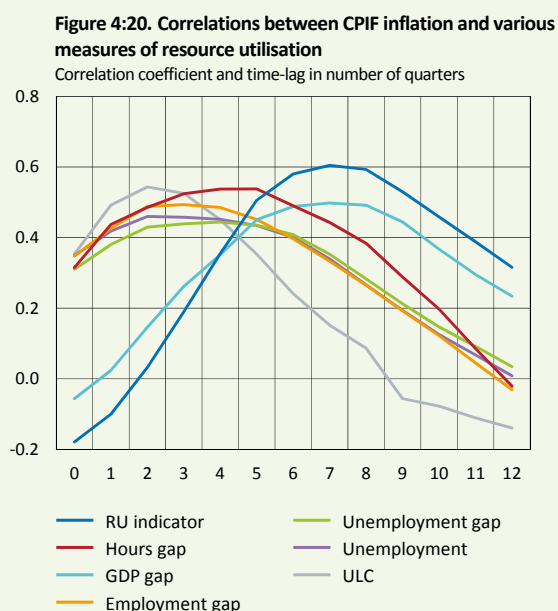
[10] See for instance Blanchard, Cerruti and Summers (2015)), "Inflation and activity – two explorations and their monetary policy implications" and "IMF Working paper 15/230".

[11] The correlation measures the relationship between the respective measure of resource utilisation and inflation. A correlation of, for instance, 0.6 says that a change with a standard deviation in resource utilisation tends to coincide with a change in inflation of 0.6 standard deviations.

[12] GDP gap refers to the GDP deviation from trend, calculated using a production function. The hours worked gap and the employment gap refer to the deviation of the number of hours worked and the number of employed from the Riksbank's assessed trends. The same applies to the unemployment gap. The RU indicator summarises the information in survey data and labour market data with the aid of so-called principal component analysis. Unit labour costs (ULC) are also used for comparison. The different measures of resource utilisation are normalised with the mean value zero and the standard deviation one. The ULC gap is calculated as the

correlation during the period 1998–2016 between a given measure of resource utilisation and inflation in the same quarter. The rest of the line shows the correlation between resource utilisation in one quarter and inflation in coming quarters, up to 12 quarters ahead.[13]

The time lag varies considerably between the different measures of resource utilisation. The correlation between the Riksbank's summarising indicator for resource utilisation (the RU indicator) and inflation is at its highest after approximately seven quarters, and around the same time lag applies between the GDP gap and inflation. The maximal correlation between the different labour-market related measures of resource utilisation and inflation is somewhat more contemporary and at its highest after three to five quarters.

Figure 4:20. Correlations between CPIF inflation and various measures of resource utilisation
Correlation coefficient and time-lag in number of quarters

RU indicator
Hours gap
GDP gap
Employment gap
Unemployment gap
Unemployment
ULC

Note. Annual percentage change. The correlation between unemployment and inflation is drawn with the inverse sign. See footnote 12 for a description of the various measures of resource utilisation.

Sources: Statistics Sweden and the Riksbank

Has the relationship changed over time?
Some economists have argued that the relationship between domestic resource utilisation and inflation has become less clear in recent years.[14] The basis for this is often that

inflation did not fall so much in conjunction with the international financial crisis and that, since then, it has not risen as expected during the recovery phase either. One explanation that has been put forth is that increased globalisation and competition from emerging market economies have led to companies' pricing becoming more steered by international factors and that domestic demand and the development of costs have thereby become less significant for inflation. Another explanation is the high level of confidence in inflation targeting in many countries, which has inhibited the effects of cyclical fluctuations on inflation expectations.

A study by the International Monetary Fund (IMF) examines the driving forces behind the low inflation in a number of developed countries in recent years.[15] The IMF estimates Phillips Curves for a number of countries and finds that the relationship between resource utilisation and inflation has been relatively stable over the past 20 years. To examine whether the relationships have been stable over time in Sweden, too, we estimate here a simplified version of the Phillips Curve used by the IMF, where earlier inflation, resource utilisation and import prices are all included as explanatory variables.[16] The following specification is used:

$$\pi_t = \alpha - \beta_1(u_t - u_t^*) + \beta_2\tilde{\pi}_{t-1} + \beta_3 IMPI_t$$

where π_t is inflation measured as a quarterly change in the CPIF, $u_t - u_t^*$ is the deviation in unemployment in percentage points from as estimated long-run sustainable level, $\tilde{\pi}_{t-1}$ is a moving average of inflation over the past four quarters and $IMPI_t$ is a quarterly change in the import price deflator.[17] The equation is estimated from 1990 Q1 to at the longest 2016 Q2.

Figure 4:21 shows estimates of the exchange between the unemployment gap and inflation (the coefficient β_1) over time. Although there appears to have been some decline, the exchange seems to have been relatively stable over the past 15 years. The effect of a change on the unemployment gap has had largely the same effect on inflation over the whole of this period. This is also the result attained by the IMF in its study.[18]

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percentage change in unit labour costs, minus a mean value of the percentage change for the whole period.

[13] Unlike, for instance, the measures of NAIRU ("non-accelerating-inflation rate of unemployment") the measure of resource utilisation in this article is not explicitly derived from inflation, but reflects how the level of production and employment relates to a more long-term development (or trend).

[14] With regard to the United States, many studies find that the relationship has weakened, see for instance Ball and Mazumder (2011), "Inflation dynamics and the Great recession", and Blanchard, Cerruti and Summers (2015). With regard to the euro area, on the other hand, studies indicate that the relationship has become stronger, see for instance, Oinonen and Paloviita (2014), "Updating the Euro area Philips curve: the slope has increased" and Riggi and Venditti (2015), "Failing to forecast low inflation and Philips curve instability: a Euro area perspective", International Finance, 18(1), p. 47-68.

[15] See Chapter 3, "Global disinflation in an era of constrained monetary policy", World Economic Outlook, IMF, October, 2016.

[16] Inflation expectations often play a central role in various specifications of the Phillips Curve. In Sweden, these expectations often concern future CPI inflation and their time series are relatively short. Here we model CPIF inflation and therefore choose to approximate inflation expectations by means of a moving average for earlier inflation outcomes. This version of the Phillips Curve is a somewhat simplified version of the one used in Chapter 3 of World Economic Outlook, IMF, October 2016.

[17] The unemployment gap is measured as a moving average over the past two quarters. The import price deflator and inflation are seasonally-adjusted and calculated as an annual rate.

[18] The relationship has also been estimated using other specifications. If other types of gap are included, the results will remain roughly the same. However, the estimates are sensitive to the length of the time series used in them. The relationship has also been estimated with rolling windows of 10 or 15 years over the period estimated. There is no support in these estimates, either, for the theory that the relationship has weakened in recent years.

Figure 4:21. Estimated trade-off between unemployment gap and CPIF inflation over time

■ Confidence interval
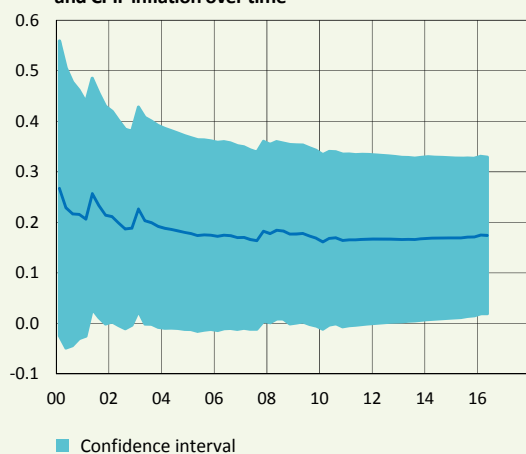
Note. The line shows the recursively estimated parameter in front of the labour market gap in the equation described in the text (β_1). The confidence interval refers to two standard deviations.

Sources: Statistics Sweden and the Riksbank

Another way of investigating whether the relationship has been stable over time is to look at correlations over different time periods. Table 4:2 shows the maximal correlation between resource utilisation and CPIF inflation divided into two different periods (the time lag for the correlation is shown in brackets). The left column shows the correlation during the period 1998 to 2007 and the right column shows the period from 2008 to the second quarter of 2016. The differences between the two periods are minor. During the earlier period, the maximal correlation with inflation was somewhat more contemporary for the labour market gap. During the latter period, the correlations are on the whole somewhat higher, but with a longer time lag between inflation and the various measures of resource utilisation on the labour market.

Table 4:2. Maximal correlation between CPIF inflation and resource utilisation during different periods

|	1998–2007	2008–2016
GDP gap	0.52 (8)	0.58 (9)
RU indicator:	0.53 (8)	0.58 (6)
Employment gap	0.59 (3)	0.63 (6)
Hours worked gap	0.60 (4)	0.55 (3)
Unemployment	0.54 (3)	0.60 (7)
Unemployment gap	0.56 (3)	0.63 (7)
ULC	0.29 (2)	0.29 (4)

The figure outside the brackets shows the maximal correlation and the figure inside the brackets shows when the correlation applies (after how many quarters).

Source: The Riksbank

Continued rise in resource utilisation indicates higher inflation during the forecast period

Sweden and many neighbouring countries have had low inflation for a number of years. One important explanation for this is that the recession period has been prolonged.[19] At the same time, the fact that resource utilisation in Sweden has risen in recent years has been a factor behind the upturn in inflation since early 2014. Inflation is also affected by other factors, such as the exchange rate and inflation expectations, and the fact that inflation has been relatively subdued so far this year reflects the uncertainty of how quickly inflation may rise. However, resource utilisation is assessed as roughly normal at present, and the Riksbank's very expansionary monetary policy provides support for a continuing rise in both resource utilisation and inflation during the forecast period (see Figure 4:22). Although it is uncertain how quickly a change in resource utilisation will have an impact on inflation and how large the effect will ultimately be, historical correlations indicate that the rising trend in inflation will continue during the forecast period.

Figure 4:22. CPIF excluding energy and the RU indicator
Standard deviation and annual percentage change respectively

— RU indicator (left scale)
····· CPIF excluding energy (right scale)
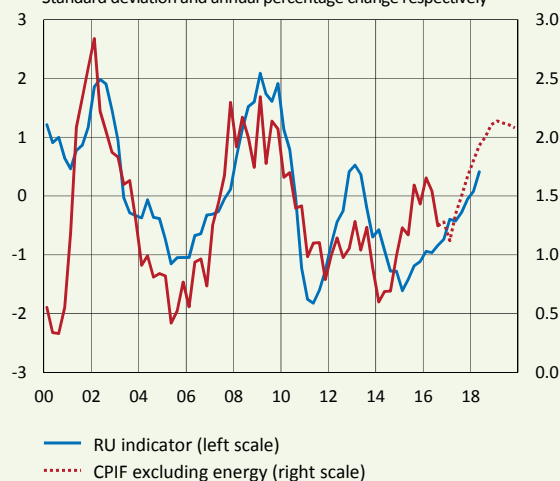
Note. The RU indicator is a measure of resource utilisation. It is normalised so that the mean value is 0 and the standard deviation is 1. The RU indicator is moved forward 8 quarters. The CPIF is the CPI with a fixed mortgage rate.

Sources: Statistics Sweden and the Riksbank

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[19] See Andersson, Corbo and Löf "Why has inflation been so low?", Economic Review 2015:3.